



Center for Advanced
Energy Studies

*A research
partnership between
Boise State University,
Idaho National
Laboratory, Idaho
State University and
University of Idaho.*

Center for Advanced Energy Studies

Modelling Employment in the American Nuclear Power Sector with Input-Output Analysis

Geoffrey Black

Steven Peterson

Energy Policy Institute, Center for Advanced Energy Studies
Idaho National Laboratory

*Presentation to OECD/NEA Expert Workshop on Modeling
Employment in the Nuclear Power Sector
OECD/NEA Headquarters, Issy-les-Moulineaux, France
February 13 – 14, 2014*



❖ *Overview*

The CAES/EPI Initiative on SMRs

- One of the main initiatives is ongoing research on the market potential and economic effects of developing a domestic SMR industry in U.S.
- Performed several studies with policy centers, national laboratories, vendors, and international agencies
 1. Estimating costs
 2. Determining economic impacts
 3. Develop decision framework for two-way market assessments
- Covered cost estimation in Session One
- Here, focus on Economic Impacts Estimation

❖ *Input-Output Analysis for SMR Industry*

Impacts from Each SMR Unit

- Each SMR unit generates impacts from its manufacture, construction, and operation
- Aggregate impacts over time for each SMR depend on the number of SMRs produced and deployed
 - Different adoption scenarios determine number of SMR units manufactured domestically (US) and deployed domestically and internationally
- Modifications due to scale:
 - Manufacture subject to modularity & scale effects
 - Scale economies less important for on-site construction and operations

❖ *Input-Output Analysis for SMR Industry*

Estimation of Economic Impacts

- Standard Input-Output Analysis
 - Industries closely linked so that activity in one industry ripples across other sectors generating direct and indirect impacts
 - These generate increased economic activity in sectors unrelated to direct and indirect sectors
- Three avenues of economic impacts
 - Direct – expenditures, salaries of firm/industry itself
 - Indirect – purchase of inputs from other firms industries
 - Induced – direct and indirect dollars re-spent in the economy

❖ *Input-Output Analysis for SMR Industry*

Estimation of Economic Impacts

- Four main outputs for impact estimation:
 - Sales
 - Total increase in sales. Broadest measure
 - Value-added
 - Analogous to GDP (can be national, region, state, county)
 - Earnings (payroll)
 - Employee compensation and proprietor income
 - Employment
 - Impacts on full and part-time employment
 - Indirect Business Taxes
 - Sales, property, excise, other taxes (except PIT, CIT)

❖ *Input-Output Analysis Using IMPLAN*

Features of IMPLAN Software Package

- IMPLAN (Impacts for Planning) is the most widely used input/output modeling software and data package in North America.
 - IMPLAN is expanding in Canada, OCED nations, and other countries around the globe.
- Forty-eight international county data sets are now available.
- IMPLAN can also work with researchers to custom build data sets for virtually any country in the world.
- IMPLAN is one of the most affordable data and software packages

❖ *Input-Output Analysis Using IMPLAN*

Data Availability of IMPLAN Software Package

- IMPLAN has been providing consistent annual updated data sets since 1996.
- IMPLAN's data sets range from national level data sets to small rural communities.
- IMPLAN has three options for regionalizing data if needed for sub-national studies:
 - Demand-supply pooling
 - Econometric RPCs
 - Newer Trade-flow option

❖ *Input-Output Analysis Using IMPLAN*

Estimating Economic Impacts

- Economic impacts can be estimated in a variety of methodologies:
 1. Using the IMPLAN software package and reported outputs.
 2. Download the transaction's matrix into a spreadsheet or GAMS modeling software (or like software), modifying the data, and estimating the multipliers yourself.
 3. Run the analysis in IMPLAN and download the multipliers to run the analysis in other media.
- IMPLAN is (mostly) transparent. Any of its data sets and analyses can be downloaded and replicated. Only a few black-boxes (Type II multipliers for example).

❖ *Input-Output Analysis Using IMPLAN*

Estimating Economic Impacts

- IMPLAN has 440 economic sectors.
 - There is a bridge map to the North American Industrial Classification System (NAICS) code system
- IMPLAN models have a built-in aggregation system that can aggregate models to virtually any way desired by the researcher.
- Aggregation is often used for the ease of modeling
 - But can introduce aggregation error into the analysis (which can overstate the multipliers)

❖ *Input-Output Analysis Using IMPLAN*

Impacts from Each NOAK Unit

- Manufacture, construction, deployment, operations
 - Discussed earlier with improvements due to better cost estimation

Impacts from Industry Development

- Design, engineering, and licensing phase
 - This has been underway and has already had economic impacts
- Manufacturing Sector Development
 - Includes design and construction of manufacturing facilities to build SMRs
 - Plus manufacture and construction of FOAK units

❖ *Input-Output Analysis Using IMPLAN*

Cumulative Impacts

- Continued Manufacturing of NOAK SMR Units
 - How many SMR units are manufactured annually?
- Ongoing Operations once SMR units deployed
 - How many units deployed domestically?
 - How many units deployed internationally?

❖ *Results of I-O Analysis*

Results of Estimated Impacts from:

- Design, Engineering, Licensing Phase
 - SMR Manufacturing Industry Development
 - NOAK Manufacture, Construction, Operations
 - Cumulative Impacts Over Time
- 
- A decorative graphic in the bottom left corner of the slide consists of a series of light blue lines that curve upwards and outwards, creating a fan-like or wave-like pattern.

❖ Results of I-O Analysis

Design/Engineering/Licensing

- \$450 million

(DOE \$67million to date, SMR award \$452 million (cost share for 2 projects))

Design/Engineering/Licensing Economic Impacts: USA

	Sales	Value-Added	Earnings (Payroll)	Employment	Indirect Business Taxes
Total	\$ 1,294,086,299	\$ 793,751,372	\$ 583,517,685	10,198	\$ 41,809,841

❖ *Results of I-O Analysis*

Development of SMR Manufacturing Industry

- Estimate \$300 million for manufacturing facilities

(Industry estimates, 2011 Univ Chicago study)

SMR Manufacturing Industry with FOAK: USA

	Sales	Value-Added	Earnings (Payroll)	Employment	Indirect Business Taxes
Manufacturing	\$1,911,674,633	\$987,538,040	\$610,374,357	10,474	\$53,134,739
Construction	\$519,451,142	\$274,259,684	\$182,484,398	3,618	\$15,201,434
Total SMR Production	\$2,431,125,775	\$1,261,797,724	\$792,858,755	14,092	\$68,336,173
Annual Operations	\$101,566,466	\$76,471,996	\$26,586,992	356	\$ 13,100,859
Total	\$2,532,692,241	\$1,338,269,720	\$819,445,747	14,448	\$81,437,032

❖ *Results of I-O Analysis*

NOAK Manufacture, Construction, Operation

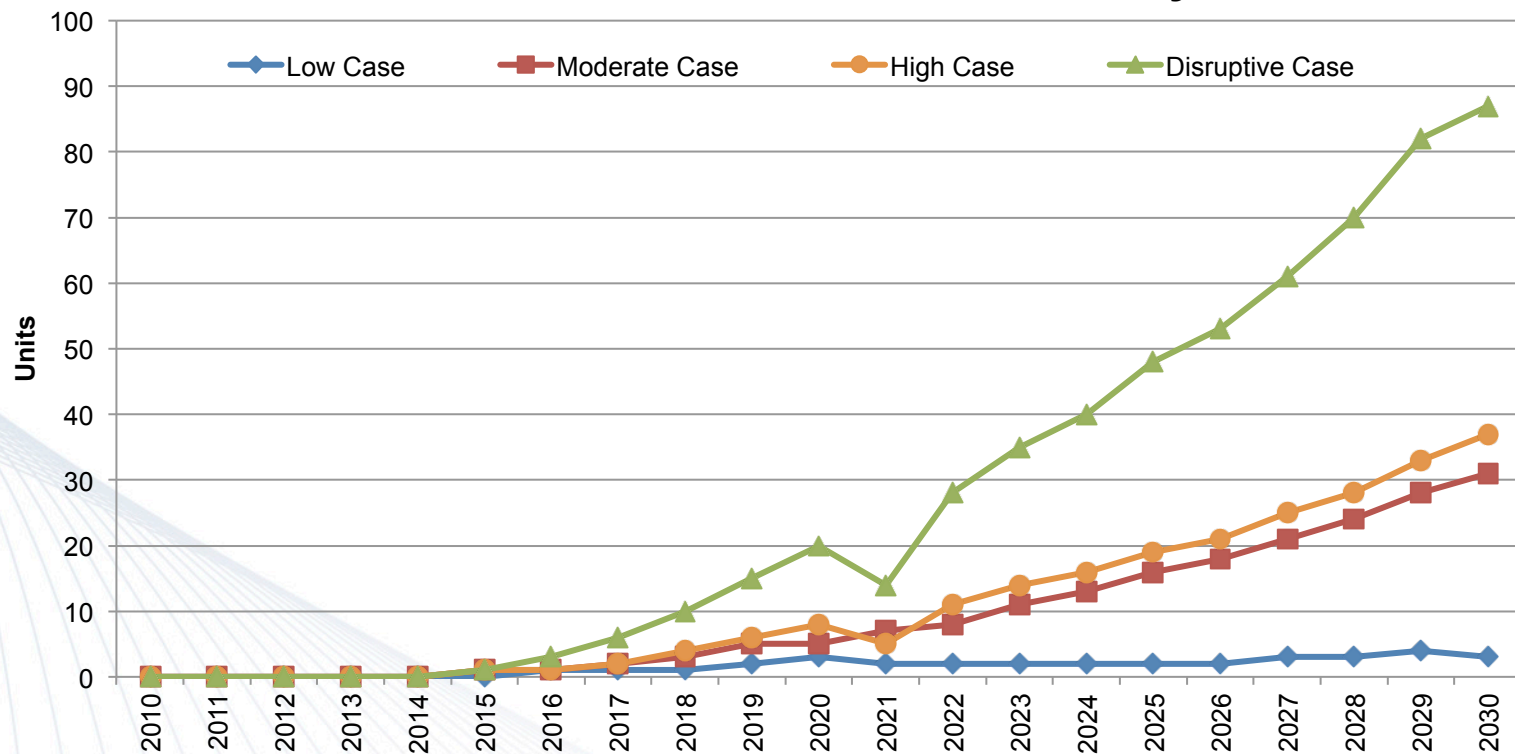
Representative 100 MWe SMR Unit					
	Sales	Value-Added	Earnings (Payroll)	Employment	Indirect Business Taxes
Manufacturing	\$1,135,744,458	\$610,371,869	\$393,450,747	6,792	\$32,042,119
Construction	\$519,451,142	\$274,259,684	\$182,484,398	3,618	\$15,201,434
Total SMR Production	\$1,655,195,600	\$884,631,553	\$575,935,145	10,410	\$47,243,553
Annual Operations	\$101,566,466	\$76,471,996	\$26,586,992	356	\$13,100,859
Total	\$1,756,762,066	\$961,103,549	\$602,522,138	10,767	\$60,344,412

❖ Results of I-O Analysis

Estimating Cumulative Impacts

- Results here based on NOAK deployment schedule using Moderate Nuclear Adoption from 2010 CAES study

Total SMRs Manufactured in the US each year



❖ *Results of I-O Analysis*

Estimating Cumulative Impacts

- Deployment begins in 2021 with gradual increase to 14 units deployed annually in the U.S. by 2030
 - No international sales included here
- Each unit deployed in the US will generate economic impacts due to operating from initial deployment through 2030
 - No international sales included (refueling, maintenance)
- Operations
 - Revenues cover O&M, re-fueling
\$0.075/kWh, 95% efficiency, 100 MWe, 8760 hrs/year: \$62.4 million

❖ *Economic Impacts: Cumulative Impacts*

Cumulative Economic Impacts of N-Kind SMRs in US: 2021-2030

	Sales	Value-Added	Earnings (Payroll)	Job Years	Indirect Business Taxes
Construction/ Manufacturing	\$79,502,112,068	\$42,726,030,860	\$27,541,552,322	475,438	\$2,242,948,363
Operations	\$147,524,124,402	\$77,889,750,160	\$51,825,568,972	1,027,640	\$4,317,207,184
Total	\$227,026,236,471	\$120,615,781,020	\$79,367,121,293	1,503,079	\$6,560,155,546

❖ *Economic Impacts - Summary*

Important findings thus far

- Each stage of developing SMR industry will bring large job creation and generate a substantial increase in economic activity
- Design, engineering, licensing phase
 - These Pre-Manufacturing Activities
 - Creates over 10,000 jobs; and
 - Generates:
 - Nearly \$1.3 billion in sales
 - Over \$580 million in earnings (payroll) and
 - Over \$40 million in indirect business taxes

❖ *Economic Impacts - Summary*

Important findings thus far

- Developing a manufacturing industry
 - Infrastructure and supply chain development to manufacture First of a Kind (FOAK) and (NOAK) units
 - Employment impacts: Over 14,000 jobs
 - Total sales: Over \$2.4 billion
 - Payroll: Nearly \$800 billion
 - Indirect business taxes: Nearly \$70 million

These include building and deploying the FOAK Unit

Additional impacts from annual operation of FOAK unit

❖ *Economic Impacts - Summary*

Important findings thus far

- The impacts from manufacturing and operating SMRs will generate significant and sustained economic activity and job creation for years
 - Employment for first 10 years of moderate levels of SMR manufacture and operations – in US only – results in:
 - Nearly \$80 billion in earnings for US workers
 - Over \$225 billion in economic activity for US businesses
 - Provides indirect business tax revenues of over \$6.5 billion, plus personal and corporate tax revenues

❖ *Economic Impacts - Summary*

Important findings thus far

- In addition to significant job creation and sustained economic development, developing a domestic SMR industry increases our human capital
 - Increased expertise
 - Increased productivity
 - Increased service exports

❖ *Economic Impacts - Summary*

Important Implications for the future

- Will help protect U.S. industrial capacity and base which has been declining in relative terms over time.
- Will create a cluster effect and synergies with other industries which will amplify the economic impacts of SMRs.
- Will give a boost to the emphasis of STEM education in the U.S. (Science, Technology, Engineering, and Math).

❖ *Economic Impacts - Summary*

Avenues for future research

- The improvement of the COAs in SMRs and the greater sectorial detail, will provide a more detailed and accurate mapping of the IMPLAN/NAICAS. This will improve the accuracy of the future economic impacts.
- Explore custom built IMPLAN production functions.
- Improve the sub-national regional COAs (i.e. regionalize the COAs) to improve regional or state economic impact assessments.
- Improve the greater international linkages of the COAS to explore the economic impacts globally across nation states.

❖ *Thank You*

- For Further Information, Please Contact:

Geoffrey Black, PhD
Energy Policy Institute
gblack@boisestate.edu
(208) 426-1359

Steven Peterson
Clinical Assistant Professor, Economics
University of Idaho
Stevenp@uidaho.edu
(208) 885-5730